

SUBSTITUTE FORM PTO-1390

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER
12758-025001

**TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371**

U.S. APPLICATION NO. (If Known, see 37 CFR 1.5)
09/787868

INTERNATIONAL APPLICATION NO.
PCT/DE99/03079

INTERNATIONAL FILING DATE
24 September 1999

PRIORITY DATE CLAIMED
25 September 1998

TITLE OF INVENTION
PROGRAMMABLE MOBILE RADIOTELEPHONE TERMINAL

APPLICANT(S) FOR DO/EO/US
Klaus-Dieter Pillekamp, Xihe Tuo, Bernd Bienek and Dietmar Gapski

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)).
4. ☒ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☒ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☒ An English language translation of amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☒ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 16 below concern other documents or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☐ A FIRST preliminary amendment.
☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☐ Other items or information:

☐
☐
☐
☐
☐

CERTIFICATE OF MAILING BY EXPRESS MAIL

Express Mail Label No **EL370011323US**

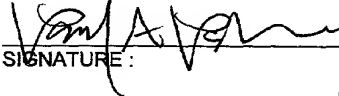
I hereby certify under 37 CFR §1.10 that this correspondence is being deposited with the United States Postal Service as Express Mail Post Office to Addressee with sufficient postage on the date indicated below and is addressed to the Commissioner for Patents, Washington, D.C. 20231

March 22, 01
Date of Deposit

Signature

Typed Name of
Person Signing

Samantha Bell
Samantha Bell

U.S. APPLICATION NO. (IF KNOWN) 09/787868		INTERNATIONAL APPLICATION NO. PCT/DE99/03079		ATTORNEY'S DOCKET NUMBER 12758-025001	
17. <input checked="" type="checkbox"/> The following fees are submitted: Basic National Fee (37 CFR 1.492(a)(1)-(5)): Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$1000 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$860 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$710 International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$690 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) \$100 <div style="text-align: right;">ENTER APPROPRIATE BASIC FEE AMOUNT =</div>				CALCULATIONS PTO USE ONLY	
Surcharge of \$130 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				\$0.00	
Claims	Number Filed	Number Extra	Rate		
Total Claims	31 - 20 =	11	x \$18	\$198.00	
Independent Claims	3 - 3 =	0	x \$80	\$0.00	
MULTIPLE DEPENDENT CLAIMS(S) (if applicable)			+ \$270	\$270.00	
TOTAL OF ABOVE CALCULATIONS =				\$1,328.00	
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				\$0.00	
SUBTOTAL =				\$1,328.00	
Processing fee of \$130 for furnishing the English Translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f))				\$0.00	
TOTAL NATIONAL FEE =				\$1,328.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +				\$0.00	
TOTAL FEES ENCLOSED =				\$1,328.00	
				Amount to be refunded:	\$
				Charged:	\$
a. <input checked="" type="checkbox"/> A check in the amount of \$1,328.00 to cover the above fees is enclosed. b. <input type="checkbox"/> Please charge my Deposit Account No. 06-1050 in the amount of \$0.00 to cover the above fees. A duplicate copy of this sheet is enclosed. c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 06-1050. A duplicate copy of this sheet is enclosed.					
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b) must be filed and granted to restore the application to pending status.					
SEND ALL CORRESPONDENCE TO:					
Paul A. Pysher FISH & RICHARDSON P.C. 225 Franklin Street Boston, MA 02110-2804 (617) 542-5070 phone (617) 542-8906 facsimile			<div style="text-align: center;">  SIGNATURE: </div> <div style="text-align: center;"> NAME Paul A. Pysher </div> <div style="text-align: center;"> REGISTRATION NUMBER 40,780 </div>		

10/PRTS

JC10 Rec'd PCT/PTO 22 MAR 2001

GR 98 P 2638 Foreign version

- 1 -

09/787868

Description

Programmable mobile phone terminal

5 The invention relates to a mobile phone terminal having a transmitter stage, a receiver stage and an antenna switch-over and adapter stage, which each have an arrangement of passive structural elements and can be programmed in, in each case, at least one
10 functional parameter. The invention also relates to a programmable mobile phone filter circuit and a programmable mobile phone RF block.

Mobile phone terminals are, as far as their telecommunications part is concerned, mobile phone
15 receiver and transmitter stations which operate in the microwave range. The use of operating frequencies near or in the gigahertz range (for example approximately 900 MHz in the GSM system and approximately 1800 MHz in the DCS system) causes complicated propagation
20 conditions to be decisive for their operation, the consequences of which conditions - in particular very severely fluctuating fading over time as a result of superimposition and multipath reception - make it necessary to take particular care when designing
25 equipment. Although the most important measures for dealing with the problems which are encountered on the propagation path (the so-called "air interface") are in the field of digital signal processing, the design of the RF components is, however, also highly significant
30 in terms of ensuring the necessary transmission quality.

In this context it is desirable to embody essential functional parameters of the RF sections in such a way that they can be adjusted very quickly over
35 a relatively large range in a way which is easy and adapted to the overall design of the mobile phone terminal. Comprehensive programmability of the RF

GR 98 P 2638 Foreign version

- 1a -

sections is considered to be ideal, but the practical embodiment of the RF sections of mobile phone terminals is far removed from such programmability. It is currently restricted to the possibility of

switching a function block on and off, controlling the output power or amplifying a block by means of changes in bias voltages or currents or the like.

In mobile phone devices according to the prior art there is practically no possibility of changing or programming the electronic components such as the RF blocks or filter circuits, for example. However, in order to provide so-called software-defined mobile phones or the like, the electronic or electrical components in the mobile phone must be as freely programmable as possible, and this programmability should also still be present after the final fabrication of the mobile phone device. Furthermore, because, as is known, components with small dimensions, high linearity and low power consumption are desirable in mobile phone applications, products which are based on a yig, pin-diode or varactor technology have corresponding disadvantages.

In particular, the filters and duplexers used in mobile phone devices should therefore have small dimensions, low power consumption, high linearity and furthermore be as freely programmable as possible.

The invention is based on the object of making possible a mobile phone terminal which is improved with respect to the aspect of the programmability of the essential functional parameters of the RF sections.

This object is achieved by means of features of the independent claims.

The invention includes the essential idea of providing a microswitch arrangement or microrelay arrangement in each of the RF transmitter stage, RF receiver stage and the antenna switch-over and adapter stage, that is to say the essential RF components, with which arrangement the

passive structural elements which are contained there and which determine specific functional parameters can be configured in a predetermined fashion from subelements.

5 Such microswitches or microrelays are known in various embodiments from US 5 619 061, in which their application for tuning a filter circuit or for antenna selectivity tuning is also mentioned.

10 An embodiment in which at least one of the aforesaid RF components also has micromotors for mechanically adjusting passive structural elements is preferred, the micromotors likewise having a control connection to a control unit by means of which the microswitches and microrelays are actuated. The
15 configuration of the structural elements, determining the characteristic values, of the respective RF component can be optimized further in terms of overall volume, power consumption, linearity and expenditure on actuation by means of the combined use of a microswitch
20 arrangement and of adjustment motors.

 In order to reduce the overall size and the manufacturing expenditure, it is advantageous to adopt an embodiment in which at least some of the microswitches and relays and, if they are additionally
25 provided, micromotors are integrated with the passive structural elements influenced by them on a common substrate. A ceramic substrate with a high dielectric constant is particularly suitable for this.

 The passive structural elements which are
30 subdivided into subelements form, together with the microswitches connecting the subelements, a topology which is expediently stored in a topology memory of the control unit. Furthermore, in one preferred embodiment, the control device comprises an algorithm memory for
35 storing a calculation algorithm for the functional parameter or parameters to be programmed, and a calculation stage for calculating the active topology

- 3a -

[illegible]

comparator means it is possible to acquire a switching matrix directly from a comparison of the calculated active topology with the totality of the topology present, which switching matrix is then implemented by transmitting appropriate switching control signals to the individual microswitches.

In one modified embodiment the control unit comprises a multirange configuration memory (in the manner of a so-called "lookup table") for storing a multiplicity of microswitch switching matrices with the topology implemented in the RF section, in each case in an assignment to a value of a functional parameter or a values vector of a plurality of functional parameters, and a pointer stage for addressing the configuration memory, which pointer stage responds to the inputting (programming) of such a value or values vector.

If micromotors are additionally present, both aforesaid ways of implementing the invention are possible with a somewhat increased expenditure on memory, or memory and processing. The sections of the structural element arrangement which are influenced by micromotors are advantageously subdivided here into (virtual) subelements corresponding to the motor settings which can be implemented, and their structure can thus be stored and handled in a fashion analogous to a structure of real subelements separated from one another by microswitches.

In particular, the frequency characteristic of the respective RF component is to be regarded as a functional parameter which is to be set in discrete increments (by activating the microswitches and optionally micromotors). Capacitors and/or inductors and/or microstrip line sections or else resonators are provided as passive structural elements to be switched. These all basically exhibit linear characteristics with the result that, in comparison with influencing the frequency characteristic by means of active structural

GR 98 P 2638 Foreign version

- 4a -

elements such as varactors or transistors, there is no risk of any nonlinearities or

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
750
751
752
753
754
755
756
757
758
759
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
780
781
782
783
784
785
786
787
788
789
790
791
792
793
794
795
796
797
798
799
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
861
862
863
864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885
886
887
888
889
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
1000
1001
1002
1003
1004
1005
1006
1007
1008
1009
1010
1011
1012
1013
1014
1015
1016
1017
1018
1019
1020
1021
1022
1023
1024
1025
1026
1027
1028
1029
1030
1031
1032
1033
1034
1035
1036
1037
1038
1039
1040
1041
1042
1043
1044
1045
1046
1047
1048
1049
1050
1051
1052
1053
1054
1055
1056
1057
1058
1059
1060
1061
1062
1063
1064
1065
1066
1067
1068
1069
1070
1071
1072
1073
1074
1075
1076
1077
1078
1079
1080
1081
1082
1083
1084
1085
1086
1087
1088
1089
1090
1091
1092
1093
1094
1095
1096
1097
1098
1099
1100
1101
1102
1103
1104
1105
1106
1107
1108
1109
1110
1111
1112
1113
1114
1115
1116
1117
1118
1119
1120
1121
1122
1123
1124
1125
1126
1127
1128
1129
1130
1131
1132
1133
1134
1135
1136
1137
1138
1139
1140
1141
1142
1143
1144
1145
1146
1147
1148
1149
1150
1151
1152
1153
1154
1155
1156
1157
1158
1159
1160
1161
1162
1163
1164
1165
1166
1167
1168
1169
1170
1171
1172
1173
1174
1175
1176
1177
1178
1179
1180
1181
1182
1183
1184
1185
1186
1187
1188
1189
1190
1191
1192
1193
1194
1195
1196
1197
1198
1199
1200
1201
1202
1203
1204
1205
1206
1207
1208
1209
1210
1211
1212
1213
1214
1215
1216
1217
1218
1219
1220
1221
1222
1223
1224
1225
1226
1227
1228
1229
1230
1231
1232
1233
1234
1235
1236
1237
1238
1239
1240
1241
1242
1243
1244
1245
1246
1247
1248
1249
1250
1251
1252
1253
1254
1255
1256
1257
1258
1259
1260
1261
1262
1263
1264
1265
1266
1267
1268
1269
1270
1271
1272
1273
1274
1275
1276
1277
1278
1279
1280
1281
1282
1283
1284
1285
1286
1287
1288
1289
1290
1291
1292
1293
1294
1295
1296
1297
1298
1299
1300
1301
1302
1303
1304
1305
1306
1307
1308
1309
1310
1311
1312
1313
1314
1315
1316
1317
1318
1319
1320
1321
1322
1323
1324
1325
1326
1327
1328
1329
1330
1331
1332
1333
1334
1335
1336
1337
1338
1339
1340
1341
1342
1343
1344
1345
1346
1347
1348
1349
1350
1351
1352
1353
1354
1355
1356
1357
1358
1359
1360
1361
1362
1363
1364
1365
1366
1367
1368
1369
1370
1371
1372
1373
1374
1375
1376
1377
1378
1379
1380
1381
1382
1383
1384
1385
1386
1387
1388
1389
1390
1391
1392
1393
1394
1395
1396
1397
1398
1399
1400
1401
1402
1403
1404
1405
1406
1407
1408
1409
1410
1411
1412
1413
1414
1415
1416
1417
1418
1419
1420
1421
1422
1423
1424
1425
1426
1427
1428
1429
1430
1431
1432
1433
1434
1435
1436
1437
1438
1439
1440
1441
1442
1443
1444
1445
1446
1447
1448
1449
1450
1451
1452
1453
1454
1455
1456
1457
1458
1459
1460
1461
1462
1463
1464
1465
1466
1467
1468
1469
1470
1471
1472
1473
1474
1475
1476
1477
1478
1479
1480
1481
1482
1483
1484
1485
1486
1487
1488
1489
1490
1491
1492
1493
1494
1495
1496
1497
1498
1499
1500
1501
1502
1503
1504
1505
1506
1507
1508
1509
1510
1511
1512
1513
1514
1515
1516
1517
1518
1519
1520
1521
1522
1523
1524
1525
1526
1527
1528
1529
1530
1531
1532
1533
1534
1535
1536
1537
1538
1539
1540
1541
1542
1543
1544
1545
1546
1547
1548
1549
1550
1551
1552
1553
1554
1555
1556
1557
1558
1559
1560
1561
1562
1563
1564
1565
1566
1567
1568
1569
1570
1571
1572
1573
1574
1575
1576
1577
1578
1579
1580
1581
1582
1583
1584
1585
1586
1587
1588
1589
1590
1591
1592
1593
1594
1595
1596
1597
1598
1599
1600
1601
1602
1603
1604
1605
1606
1607
1608
1609
1610
1611
1612
1613
1614
1615
1616
1617
1618
1619
1620
1621
1622
1623
1624
1625
1626
1627
1628
1629
1630
1631
1632
1633
1634
1635
1636
1637
1638
1639
1640
1641
1642
1643
1644
1645
1646
1647
1648
1649
1650
1651
1652
1653
1654
1655
1656
1657
1658
1659
1660
1661
1662
1663
1664
1665
1666
1667
1668
1669
1670
1671
1672
1673
1674
1675
1676
1677
1678
1679
1680
1681
1682
1683
1684
1685
1686
1687
1688
1689
1690
1691
1692
1693
1694
1695
1696
1697
1698
1699
1700
1701
1702
1703
1704
1705
1706
1707
1708
1709
1710
1711
1712
1713
1714
1715
1716
1717
1718
1719
1720
1721
1722
1723
1724
1725
1726
1727
1728
1729
1730
1731
1732
1733
1734
1735
1736
1737
1738
1739
1740
1741
1742
1743
1744
1745
1746
1747
1748
1749
1750
1751
1752
1753
1754
1755
1756
1757
1758
1759
1760
1761
1762
1763
1764
1765
1766
1767
1768
1769
1770
1771
1772
1773
1774
1775
1776
1777
1778
1779
1780
1781
1782
1783
1784
1785
1786
1787
1788
1789
1790
1791
1792
1793
1794
1795
1796
1797
1798
1799
1800
1801
1802
1803
1804
1805
1806
1807
1808
1809
1810
1811
1812
1813
1814
1815
1816
1817
1818
1819
1820
1821
1822
1823
1824
1825
1826
1827
1828
1829
1830
1831
1832
1833
1834
1835
1836
1837
1838
1839
1840
1841
1842
1843
1844
1845
1846
1847
1848
1849
1850
1851
1852
1853
1854
1855
1856
1857
1858
1859
1860
1861
1862
1863
1864
1865
1866
1867
1868
1869
1870
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881
1882
1883
1884
1885
1886
1887
1888
1889
1890
1891
1892
1893
1894
1895
1896
1897
1898
1899
1900
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
2042
2043
2044
2045
2046
2047
2048
2049
2050
2051
2052
2053
2054
2055
2056
2057
2058
2059
2060
2061
2062
2063
2064
2065
2066
2067
2068
2069
2070
2071
2072
2073
2074
2075
2076
2077
2078
2079
2080
2081
2082
2083
2084
2085
2086
2087
2088
2089
2090
2091
2092
2093
2094
2095
2096
2097
2098
2099
2100
2101
2102
2103
2104
2105
2106
2107
2108
2109
2110
2111
2112
2113
2114
2115
2116
2117
2118
2119
2120
2121
2122
2123
2124
2125
2126
2127
2128
2129
2130
2131
2132
2133
2134
2135
2136
2137
2138
2139
2140
2141
2142
2143
2144
2145
2146
2147
2148
2149
2150
2151
2152
2153
2154
2155
2156
2157
2158
2159
2160
2161
2162
2163
2164
2165
2166
2167
2168
2169
2170
2171
2172
2173
2174
2175
2176
2177
2178
2179
2180
2181
2182
2183
2184
2185
2186
2187
2188
2189
2190
2191
2192
2193
2194
2195
2196
2197
2198
2199
2200
2201
2202
2203
2204
2205
2206
2207
2208
2209
2210
2211
2212
2213
2214
2215
2216
2217
2218
2219
2220
2221
2222
222

distortions. In addition, the electrostatically controlled microswitches do not have any power drain.

For the concrete setting process, a specific procedure is to be observed in order to protect the microswitches, and if appropriate micromotors or else other parts of the arrangement, against overcurrents and voltage peaks. To do this, the RF component which is to be adjusted and preferably the entire RF section are switched to an inactive state. Subsequently, the currently required microswitch configuration or the combination of microswitch configuration and micromotor actuation which is to be implemented can be determined in one of the ways sketched above. Finally, the predetermined switch configuration or combination of switch setting/motor actuation is implemented by means of the control unit, and last of all the RF components or the entire mobile phone terminal are changed into the active state again. A functionality (programming) of the control unit which implements the sequence automatically corresponds of course to the procedure described here.

According to a further aspect, a programmable RF block is provided for mobile phone applications. This programmable RF block has at least one active component and at least one mechanically tunable adapter network which has individually adjustable passive components and is connected to the active component. Furthermore, a programmable control unit is provided which sets the mechanically tunable adapter network in such a way that all the properties of the RF block relating to its signal response characteristic are predetermined.

Each adjustable passive component can be assigned an electric micromotor here, with the result that the programmable control unit can perform the adjustment of the mechanically tunable adapter network by actuating the micromotors.

The micromotors are activated here only during the period of adjustment of the mechanically tunable adapter network, whereas, outside the aforesaid period, the supply of electricity to the micromotors is
5 switched off by, for example, the programmable control unit in order to reduce the power consumption, which is important in particular in mobile phone applications.

According to a further aspect of the present invention, a programmable filter circuit is provided
10 for mobile phone applications, said filter circuit having a plurality of passive components whose characteristic values are each mechanically adjustable. These passive components are wired according to filter circuit topologies which are well known from the prior
15 art. Furthermore, electric micromotors are provided for mechanically adjusting the passive components. These electric micromotors are actuated by a programmable control unit in such a way that the filter circuit has a characteristic curve which is predetermined in its
20 entirety.

The control unit can be connected here to a memory in which setting values of the passive components or actuation values for the corresponding electric micromotors and/or characteristic curves of
25 the filter circuit are stored, for example in the form of a table.

Alternatively or in addition, the control unit itself the control unit itself can calculate the actuation values for the electric micromotors which are
30 to be transmitted in order to achieve a specific characteristic curve of the filter circuit.

At least some of the passive components can be capacitors which have a mechanically adjustable capacitance, the capacitors being constructed with a
35 high dielectric constant using a ceramic technology for the sake of small dimensions.

The capacitors can have, for example, rotatable or slidable metal plates which are moved by the electric micromotors in order to adjust their capacitance values mechanically.

5 Some of the passive components may be resonators, it being possible to change the position of a short-circuit conductor with respect to a grounding point by means of the corresponding electric micromotor in order to mechanically adjust the characteristic
10 values (tuning) of the resonators.

In order to save energy, the electric micromotors can be actuated in such a way that they are supplied with electric power only during the period in which a corresponding, assigned passive component is
15 being mechanically adjusted.

According to the present invention, a programmable duplexer is also provided for mobile phone applications which has a plurality of programmable filter circuits according to one of the preceding
20 claims, the programmable filter circuits being adjusted by the control unit in such a way that they have different frequency characteristic curves.

Advantages and expedient aspects of the invention are, for the rest, apparent from the
25 subclaims and the following description of preferred exemplary embodiments with reference to the figures, in which:

Fig. 1 shows a highly simplified functional block circuit diagram of a mobile phone terminal for
30 explaining the invention with reference to an embodiment,

Fig. 2a shows a basic circuit diagram of a resonator circuit such as is used in one of the filter modules or in the duplexer

of the mobile phone terminal according to Fig. 1,

Figures 2b to 2e show various ways of implementing the circuit according to Fig. 2a according to embodiments of the invention using microswitches or microrelays,

Figures 2f and 2g show modified embodiments of a tunable resonator circuit in which not only microrelays or microswitches but also micromotors are provided,

Fig. 3 shows a functional block circuit diagram of a control arrangement for tuning a filter stage of the mobile phone terminal according to Fig. 1,

Fig. 4 shows a sketch of the control system according to a further embodiment,

Figs 5a - 5c show schematic circuit diagrams of exemplary embodiments of the present invention in which tunable adapter networks are connected to an amplifier (Fig. 5a), a mixer (Fig. 5b) and an oscillator (Fig. 5c),

Fig. 6 shows a detailed view of a tunable adapter network according to the present invention,

Fig. 7a shows a schematic circuit diagram of a programmable filter circuit according to the invention,

Fig. 7b shows a duplexer which has two programmable filter circuits whose components are adjusted in such a way that the filter circuits

all have different frequency characteristic curves,

Fig. 8 shows an exemplary embodiment of the implementation of a filter circuit composed of capacitors and inductors/resonators whose characteristic values can be mechanically adjusted,

Fig. 9 shows a detail of Fig. 8 which is designated by a) in Fig. 2, Fig. 9 also illustrating the actuation in order to adjust the characteristic values of a capacitor,

Fig. 10 shows a detail from Fig. 8 which shows the plan view of a line resonator whose electrical properties are changed by a short-circuit slide which is designated by b) in Fig. 8, and

Fig. 11 shows a further exemplary embodiment for providing a capacitor whose capacitance value can be adjusted mechanically by a micromotor.

Fig. 1 shows a highly simplified basic sketch of a mobile phone terminal 1 which has a baseband block 3 which comprises, in particular, the low-frequency components and voice signal processing means, a receiver stage 5, a transmitter stage 7, a control section 9, a duplexer 11 and an antenna 13. Provided in the transmitter-end signal path is, in each case, a tunable transmit-signal filter stage 15a, 15b between the baseband block 3 and the transmitter stage 7, and between the latter and the duplexer 11, respectively, and in each case a tunable receive-signal filter stage 17a, 17b is provided in the receiver-end signal path between the duplexer 11 and the receiver stage 5, and between the latter and the baseband block 3, respectively.

In summary, the receiver stage 5 and the associated receive-signal filter stages 17a, 17b can also be referred to as a receiver stage in the broader sense, and the transmitter stage 7 together with the transmit-signal filter stages 15a, 15b can be referred to as a transmitter stage in the broader sense. In a somewhat different way of considering the components, the tunable filter stages 15b and 17a could also be apportioned to the duplexer 11, and this combined functional unit could be referred to as an antenna switch-over and adapter stage. Insofar as the baseband block has (means known per se) for source coding, channel coding and interleaving as well as burst formation at the transmitter end and corresponding deinterleaving, channel decoding and source decoding means at the receiver end, there is a close functional connection to the control section, which of course has means for controlling the functional sequences of the mobile phone terminal which conform to the respective mobile phone system standard. In the context of explaining the invention, the control functions of the control section 9 relating to the receiver stage 9, the transmitter stage 7 and the filter stages 15a, 15b and 17a, 17b are particularly important. For this reason, they will be explained in more detail below.

Fig. 2a shows a resonator arrangement composed of three capacitors C1, C2 and C3 which are connected in series, and two inductors 11, 12 which connect the line section between the capacitors C1, C2 and the section between the capacitors C2, C3 to ground. Such a resonator arrangement is implemented in the filter stages 15a, 15b, 17a and 17b and/or the receiver stage and the transmitter stage in the broader sense and/or the antenna switch-over and adapter stage.

Fig. 2b shows in sketch form that the inductors 11, 12 of the arrangement according to Fig. 2a each have a multiplicity of taps, which can each be connected to ground via one microswitch, in a

GR 98 P 2638 Foreign version
- 10a -

predetermined arrangement. The microswitches which are assigned to the inductor 11 are designated

by MS_i in the figure and are actuated individually by means of "control_i" control signals, while the microswitches assigned to the inductor l_2 are designated by MS_j and are actuated by means of "control_j" control signals. The microswitches $MS_{i,j}$ separate off -
5 depending on the switch setting - more or less large parts of the inductors 11, 12, with the result that the frequency characteristic of the resonator arrangement can be adjusted by means of their actuation.

10 A somewhat modified embodiment of this principle is shown in Fig. 2c, where the inductors 11, 12 are each divided into subinductors by a group of microrelays MR_i and MR_j , actuated by actuation signals "control_i" and "control_j". This circuit in which two
15 grounding capacitors C_4 , C_5 are also provided, constitutes an open circuit, while the embodiment according to Fig. 2b can be considered to be a short circuit.

Fig. 2d shows a star-shaped switch
20 configuration which can take the place of the serial switch arrangement according to Fig. 2b or 2c. Fig. 2e shows an arrangement which is modified with respect to Fig. 2b insofar as here not only the inductors 11, 12 but also the capacitors C_1 , C_2 and C_3 are divided into
25 substructural elements by means of microswitches and can be tuned by activating the switches. In accordance with the representation in Fig. 2b, the switches assigned to the capacitors C_1 to C_3 are designated by MS_k , MS_l and MS_m and the associated control signals are
30 correspondingly designated by "control_k", "control_l" and "control_m". The subinductors of 11 are designated here by l_{a1} , l_{b1} , ... and those of 12 are designated by l_{a2} , l_{b2} , ..., and in an analogous fashion the subcapacitors of the capacitors C_1 are designated by C_{a1} , C_{b1} , C_{c1} , ...,
35 those of the capacitor C_2 are designated by C_{a2} , C_{b2} , C_{c2} , ..., and those of the capacitor C_3 are designated by C_{a3} , C_{b3} , C_{c3} , This

figure shows particularly clearly that as a result of the subdivision of passive structural elements of a filter range or adaptation range into substructural elements by means of microswitches or microrelays

a topology is developed which comprises a large number of configurations which can be implemented by actuation of switches in specific ways.

Fig. 2f shows an embodiment which is modified with respect to Fig. 2c in such a way that the capacitance of the capacitor C1 can be changed by a micromotor MM_1 , actuated by a "control_k," control signal. Of course, the capacitors C2 and C3 can also be embodied so that they are adjustable by appropriately actuating a micromotor which is assigned to them.

In the arrangement according to Fig. 2g, the arrangement shown in Fig. 2e with capacitors C1, C2 and C3 subdivided into subcapacitors is modified with respect to the inductors in such a way that the latter each have a ground tap which can be displaced by means of a micromotor MM_1 or MM_2 . By analogy to Fig. 2e, the corresponding control signals have been designated here by "control_i," and "control_j,".

Fig. 3 shows, in the manner of a functional block circuit diagram, a sketch of the design of a tuning controller 90 (whose reference number has been based on the control section 9 from Fig. 1) for tuning a receive-signal filter stage 17a according to Fig. 1. The tuning controller 90 comprises a tuning sequence controller 90a which receives a signal which is supplied externally and which represents a requested frequency characteristic of the receive-signal filter stage 17a.

The tuning sequence controller 90a is connected to the receiver state 5 via an on/off switch 90b via which it firstly switches off the receiver stage 5 when the aforesaid signal, on the basis of which the receive-signal filter stage 17a is to be tuned, is received. The signal generated for the activation of the on/off switch is also fed via an inverter 90c to a switch-configuration calculation stage 90d and activates it, after which said switch-configuration calculation stage 90d

receives and buffers the abovementioned signal which specifies a frequency characteristic and is also applied to its output. By accessing a topology memory 90e, in which the specific filter topology of the receiver filter stage 17a is stored, said topology being formed from the passive structural elements or subelements and assigned microswitches or microrelays and, if appropriate, micromotors, and accessing an algorithm memory 90f in which a corresponding algorithm for determining the specific switch configuration on the basis of a predetermined frequency characteristic is stored, the switch-configuration calculation stage 90d calculates the actuation configuration of the microswitches or relays, and if appropriate micromotors, which is to be implemented on the basis of the requested frequency characteristic, and transmits said configuration to an actuation signal generator 90g. The latter generates - also by accessing the topology memory 90e - the actuation signals for each individual switch of the entire configuration from this and feeds them sequentially to the receive-signal filter stage 17a. The transmission of the last actuation signal is sensed by a program-end detector 90h which transmits a corresponding signal to the tuning sequence controller 90a, which then activates the on/off switch 90b in order to switch the receiver stage 5 on again, and deactivates the switch-configuration calculation stage 90d. (The functions described here will for the most part be implemented in practice using software so that the description given here using functional blocks is to be understood only as an illustration of the principle).

Fig. 4 shows in sketch form (in a somewhat different form of representation) an alternative embodiment of the control system. A control unit C comprises a configuration memory M in which a predetermined quantity of switch-setting configurations of a structural element/microswitch arrangement of a RF

section R/T of a mobile phone terminal is stored in an assignment to, in each case, one frequency characteristic from a predetermined set of frequency characteristics. An input signal line S of the
5 controller C is connected on the one hand to

an on/off switch Sw and on the other hand to a pointer stage P, which can itself address the configuration memory M.

When an instruction signal for setting a
5 predetermined frequency characteristic on the signal
line S is received, the RF section R/T is placed in a
default mode by means of the on/off switch Sw, and on
the other hand the pointer P for addressing the
configuration memory M is activated in accordance with
10 the requested frequency characteristic. The memory
contents are read out to the RF section and appropriate
setting of the microswitch arrangement is performed
there. After its termination, the RF section is
activated again - in accordance with the embodiment
15 according to Fig. 3.

The embodiment of the invention is not
restricted to the exemplary embodiments described here,
but is also possible in a large number of refinements.
In particular, resistors can also be subdivided as
20 passive structural elements by means of microswitches
or microrelays into subelements and in this way, in
particular, impedance adaptations can be performed. In
this context the use of microstrip lines is
particularly expedient for many applications. A
25 combination of microswitches with micromotors can also
be expedient with passive structural elements of the
same type in the same arrangement if it leads to a
reduction in the expenditure on manufacture and the
overall volume or the expenditure on actuation.

30 Fig. 5a shows the case in which individually
adjustable tuning networks 1, 2, 3 are connected in
parallel (see tuning network 2) or serially (see tuning
networks 1, 3) to an active component, which in this
case is an amplifier 4.

35 Fig. 5b shows the case in which three
individually adjustable tuning networks 1, 2, 3 are
connected to an active component 5, which in this case
is a mixer.

Fig. 5c shows the case in which three individually adjustable tuning networks 1, 2, 3 are connected to an active component 6 which is an oscillator 6.

5 Fig. 6 shows in detailed form the design of a tuning network 101, 102, 103 according to the present invention. The tuning network 101 which is illustrated as an exemplary embodiment has three capacitors 107, 108, 109 which are connected serially between an input
10 121 and an output 122 and whose capacitance value can be individually adjusted by mechanical means. Furthermore, two inductors or resonators 110, 111 are connected between the connecting point between the capacitor 107 and the capacitor 108 and between the
15 capacitor 108 and the capacitor 109 and ground.

The capacitance values of the capacitors 107, 108, 109 can be set, for example, by sliding or rotating a metal plate of the capacitors by means of a micromotor. The characteristic values of the resonators
20 or inductors 110, 111 can be set mechanically by displacing the grounding point.

Each of the adjustable passive components 107, 108, 109, 110, 111 is assigned an electric micromotor 112, 113, 114, 115, 116 which mechanically adjusts the
25 characteristic values of the corresponding components. The micromotors 112, 113, 114, 115, 116 are actuated in this case by a control unit 217. The control unit 117 senses the signal response characteristics on the one hand of each adapter network 101, 102, 103 in which the
30 signals which are present at the input 121 or the output 122 of each adapter network 101, 102, 103 are supplied to them at inputs 119, 120, and on the other hand the overall signal response characteristics of the RF block in which the control unit 117 is supplied with
35 all the signals which are present at the input 125 or the output 126 of the RF block. The control unit 117 can thus

set all the individual passive components 107, 108, 109, 110, 111 of each mechanically tunable adapter network by means of the electric micromotors 112, 113, 114, 115 and 116 as a function of the signal response
5 characteristics of each adapter network and/or of the RF block.

As is also clear in Fig. 6, the corresponding programming of the control unit 117 can also be carried out online over an air interface 124 and an antenna
10 123. That is to say, for example, a mobile phone in which a RF block according to the present invention is installed can be programmed online from a base station over the air interface 124 and the antenna 123.

As is also clear in Fig. 6, a memory 118 is
15 connected to the control unit 117. This memory can be, for example, a PROM. Setting values for the individual passive components 107, 108, 109, 110, 111, i.e. the corresponding actuation values for the respectively assigned micromotors 112, 113, 114, 115 and 116 can be
20 permanently stored in this memory 118. Furthermore, it is possible to provide in the memory 118 a table which specifies which individual setting values are required for the passive components in order to obtain predetermined signal response characteristics of the
25 individual adapter networks 101, 102, 103 or of the RF block in its entirety.

Alternatively, the programmable control unit 117 can itself calculate the setting values, necessary to obtain a specific signal response characteristic of
30 the RF block, for the mechanically tunable adapter network or networks.

The present invention therefore ensures complete programmability of a RF block for mobile phone applications. This provides a number of advantages.
35 Firstly, owing to the use of purely passive components in the adapter networks, i.e. of mechanically

tunable capacitors, coils and resonators, electrical power is consumed only during the actual setting period. As soon as the adapter network is set, the control unit 117 can, for example, switch off the electricity supply to the electric micromotors 112, 113, 114, 115, 116 in order to ensure that no electrical power whatsoever is consumed outside the aforesaid period. This is particularly important with battery-operated mobile phones.

By virtue of the fact that only passive components are used, there are fewer problems in terms of nonlinearity and distortion, in contrast to the case in which other active components such as, for example, varactors or transistors are used. Furthermore, the size of the circuit blocks can be kept small by using a compact layout and materials with a high dielectric constant. For example, components for this purpose can be constructed using a ceramic technology. This is in turn advantageous with mobile phones.

The method which is executed in order to set a programmable RF block according to the present invention will now be explained below. Firstly, the values of the mechanically adjustable capacitor, coil and/or resonator are selected by actuating a micromotor. The movement of the micromotor is controlled by means of software in the control unit 117. In this way, the adapter network is adapted specifically for the active component connected to it (transistor, diode, etc.) using a suitable combination of capacitors, coils and resonators. A suitable topology for the adapter network is selected for each circuit type. Finally, the signal response characteristics of each RF block in a mobile phone can be set and optimized by means of a calculation or an algorithm by changing the values of the adapter network components. The control data of the control

unit 117 can be stored in the memory 118 and, if appropriate, reused when a new setting is made at a later time.

It is to be noted that the adapter network shown in Fig. 6 illustrates only one exemplary embodiment, and an adapter network according to the present invention can be constructed generally, for example, only as a capacitor but also as a complex combination of a cascade-shaped connection of capacitors, coils and resonators.

As already mentioned, all of the RF block is set with respect to its signal characteristics. When this is done, in particular the following parameters may be taken into consideration:

- a) Operating frequency at which the circuit (RF block) is to be operated,
- b) Bandwidth,
- c) Output power and amplification,
- d) Noise characteristics of the RF block.

In a circuit with a permanently predefined adapter network, the circuit parameters are predefined and can no longer be changed. The overall power achieved is thus a compromise between the various parameters.

Different applications of the present invention for different active components will now be explained in brief below.

For all types of amplifiers, mixers and oscillators, the operating frequency can be set by tuning the adapter network. The RF block can thus cover a wide frequency range in which, for example, a tunable broadband power amplifier, broadband mixer, etc. is implemented.

In all types of amplifiers and mixers, a large bandwidth can be adjusted to a smaller one and vice versa by tuning the adapter network. An overall improvement in the selectivity of the circuit can thus
5 be obtained.

In all amplifiers with low noise it is possible to optimize a configuration to an optimum noise characteristic as a function of the strength of the input signal by tuning the adapter network, for example
10 by adjusting the corresponding amplification factor. This improves, for example, the intermodulation property of the circuit.

In power amplifiers it is possible to tune with respect to the desired amplitude of the output signal
15 or the efficiency by adjusting the adapter network. It is thus possible, for example, to prolong the service life of a battery of a mobile phone.

A programmable filter circuit according to the present invention will first be explained with
20 reference to Fig. 7a.

The filter circuit illustrated in Fig. 7a has an input 219 and an output 220. Adjustable capacitors 204 are connected in series between the input 219 and the output 220. The capacitors 204 here are each of the
25 type whose capacitance value can be mechanically adjusted. To do this, in each case an electric micromotor 208 is assigned to a capacitor 204 with an adjustable capacitance. Of course, an electric micromotor can also be mechanically connected to more
30 than one capacitor 204 in order to appropriately adjust the capacitance values of the capacitors connected to it.

In each case an inductor 205 or resonator is connected between the connection points between the
35 individual capacitors 204 and ground. These inductors 205 are

also mechanically adjustable, and to this, as in the case of the capacitors 204 in the illustrated exemplary embodiment, each electric micromotor 208 is assigned to one adjustable inductor 205 in each case. The filter circuit illustrated in Fig. 7a is, as is clear, a filter circuit with n stages.

The filter topology shown in Fig. 7a is the basis of the duplexer illustrated in Fig. 5b. The duplexer illustrated in Fig. 5b has, specifically, two filter circuits 202 and 203 which are connected to an antenna 206 by means of a common line from their input 219. The filter circuit 202 has n stages here and the filter circuit 203 m stages, $n = m$ being possible. In order to provide a frequency multiplex mode (FDD) for example, the filter circuit 202 can be adjusted with respect to the passive components 204, 205 which form it, in such a way that its operating frequency differs from that of the filter circuit 203.

The programmable filter circuits 201 and 202, 203 (shown in Figs 7a and 7b) are based on a bandpass filter technology. However, it is clear that the present invention can also be applied to all other known filter technologies, for example low-pass or high-pass filters and notch filters.

The detail shown in Fig. 8 includes two mechanically adjustable capacitors 204 in which in each case a metal disk 207 is rotated in order to adjust their capacitance.

Furthermore, Fig. 8 shows three inductors/resonators 5 whose effective length can be adjusted by displacing a short-circuit conductor 215 in order to change the corresponding characteristic values of the component.

Fig. 9 shows a detail from Fig. 8, which is designated in Fig. 8 by a). The mechanically adjustable capacitor 204 shown in Fig. 9 comprises essentially a metal plate 211, which is located above a dielectric 210 in a sandwich-like fashion and is in turn located above a printed circuit board (PCB) 209. The metal disk 211 of the capacitor 204 can be rotated by means of an electric micromotor 208 in order to mechanically change the capacitance of the capacitor 204.

The electric micromotor 208 is actuated here by a control unit 217. As is illustrated symbolically by arrows in Fig. 9, the control unit 217 can also adjust, by actuating a corresponding electric micromotor 208, a plurality of passive components, or all the passive components which are mechanically adjustable and which form the filter circuit 201 and 202, 203.

The control unit 217 carries out this adjustment of the individual components in such a way that the filter circuit has, in its entirety, a predetermined frequency characteristic curve between its input 219 and its output 220 and 220'. To do this, the control unit 217 is supplied, as information, with the signals which are present at the input 219 and at the output 220, 220' of the filter circuit, as is also indicated symbolically by arrows in Fig. 3. By means of the signals supplied from the input 219 and from the output 220, 220', the control unit 217 can acquire the frequency characteristic curve of the filter circuit and determine whether this actual frequency characteristic curve corresponds to a setpoint frequency characteristic curve.

As an alternative, the control unit 217 itself can calculate the actuation values for the electric micromotors 208 which are required to obtain a predetermined frequency characteristic curve. The frequency characteristic curve which is to be set can be stored in the control unit 217 itself or else also

transmitted online to the control unit 217, for example by means of an air interface in the case of a mobile telephone.

As is also illustrated in Fig. 9, a PROM memory 218 is provided with the control unit 217. In the PROM memory 218, setting values or actuation values for the electric micromotors 208 and, if appropriate, predetermined frequency characteristic curves for the filter circuit can all be stored permanently in the form of a table. The control unit 217 can thus access the table stored in the PROM 218 in order to obtain a predetermined frequency characteristic curve of the filter circuit.

Fig. 10 shows a detail from Fig. 8 which is designated by b) in Fig. 8. In the exemplary embodiment illustrated in Fig. 10, the passive component is a resonator 205. By mechanically displacing a short-circuit conductor 205, actuated by an electric micromotor 208 in terms of its position with respect to the ground line 212, the characteristic values of the resonator 205 can be adjusted by the actuation of the control unit 217.

Fig. 11 shows a further exemplary embodiment of a mechanically adjustable capacitor 204. In this case, a metal plate 215 is displaced with respect to the dielectric 216 in a plane perpendicular to the plane of the dielectric 216, this displacement being carried out by means of an electric micromotor 208 that is in turn actuated by the control unit 217.

Of course, commercially available, tunable capacitor components can also be used for the programmed adjustment of the capacitance values of capacitors, it being possible for the adjustment to be carried out mechanically with an electric micromotor.

As is clear from the description of exemplary embodiments above, purely passive switching components are used in the present invention so that, on the one hand, the power consumption can be kept low and, on the other hand, nonlinearity problems, such as occur, for example, with yig or varactor technology, are avoided. In the programmable filter circuit according to the invention, electrical power is consumed only if a micromotor carries out an adjustment of a passive component. It is to be noted that according to the prior art electrical power is consumed continuously with pin-diode technology. As already stated, a PCB filter duplexer according to the present invention can be constructed using a ceramic technology which has a high dielectric constant, which leads to a reduction in the component dimensions.

It is to be noted that according to the prior art one or more micromotors with mechanical transmission are constructed in a very small form and can be integrated into the dimensions of a mobile unit.

It is to be noted that any known circuit topology which has a filter function or duplexer function can be used as a basis for the present invention. On this basis, the characteristic values of the adjustable (programmable) capacitor, the inductor or of a resonator can be changed in the circuit topology by means of a micromotor which can be in turn actuated electrically by means of a control unit.

By means of a calculation or a suitable algorithm it is then possible to change the characteristic values, such as the capacitance or the resonance value, for example, in such a way that the desired filter characteristic curve or duplexer characteristic curve is obtained with a desired center frequency and bandwidth.

List of reference symbols

	1	Mobile phone terminal
	3	Baseband block
5	5	Receiver stage
	7	Transmitter stage
	9	Control stage
	11	Duplexer
	13	Antenna
10	15a, 15b	Transmit-signal filter stage
	17a, 17b	Receive-signal filter stage
	C_1, C_2, C_3, C_4, C_5	Capacitor
	11, 12	Inductor
	$MS_{i, j, k, l, m}$	Microswitch
15	MM_1, MM_2	Micromotor
	90	Tuning controller
	90a	Tuning sequence controller
	90b	On/off switch
	90c	Inverter
20	90d	Switch-configuration calculation stage
	90f	Algorithm memory
	90g	Actuation signal generator
	90h	Program-end detector
25	C	Controller
	M	Configuration memory
	P	Pointer stage
	R/T	RF section
	S	Control signal line
30	Sw	On/off switch
	101	Adapter network
	102	Adapter network
	103	Adapter network
	104	Active component (amplifier)
35	105	Active component (mixer)
	106	Active component (oscillator)
	107	Capacitor
	108	Capacitor

	109	Capacitor
	110	Inductor (coil)
	111	Inductor (coil)
	112	Micromotor
5	113	Micromotor
	114	Micromotor
	115	Micromotor
	116	Micromotor
	117	Control unit
10	118	Memory
	119	Input of the control unit
	120	Input of the control unit
	121	Input terminal of the adapter network
15	122	Output terminal of the adapter network
	123	Antenna
	124	Air interface
	125	Input of the control unit
20	126	Input of the control unit
	201	Programmable filter circuit
	202, 203	Programmable filter circuits of the duplexer
	204	Adjustable capacitor
25	205	Adjustable inductor/resonator
	206	Antenna
	207	Metal disk
	208	Electric micromotor
	209	Printed circuit board
30	210	Dielectric
	211	Metal disk
	212	Grounding potential
	215	Metal plate
35	216	Dielectric

Patent claims

1. A mobile phone terminal having
 - a transmitter stage (7, 15a, 15b),
 - 5 - a receiver stage (5, 17a, 17b),
 - an antenna switch-over and adapter stage (11),which each have an arrangement of passive structural elements, which arrangement is assigned a multiplicity of electrostatic-mechanical microswitches (MS_i - MS_m) or microrelays (MR_i , MR_j) and which can be programmed by actuating a predetermined configuration of the microswitches or microrelays in, in each case, at least one functional parameter, in particular the frequency characteristic, and
 - 15 - a programmable control unit (9; 90; C) for actuating the microswitch or microrelay configuration for setting predetermined values of the functional parameter or the functional parameters.
2. The mobile phone terminal as claimed in claim 20 1, characterized in that at least one of the transmitter stage (7, 15a, 15b), receiver stage (5, 17a, 17b) and antenna switch-over and adapter stage (11) has a multiplicity of micromotors for mechanically adjusting passive structural elements, the micromotors 25 (MM_1 , MM_2) having a control connection to the control unit.
3. The mobile phone terminal as claimed in claim 1 or 2, characterized in that the control unit (90; C) has an on/off switch (90b; Sw) for the transmitter 30 stage and the receiver stage and is embodied in such a way that, in each case before an actuation signal is transmitted to the microswitch configuration or microrelay configuration, and optionally to a micromotor, a switch-off signal is transmitted to the 35 on/off switch in order to deactivate the transmitter stage and/or receiver stage (5; R/T).

4. The mobile phone terminal as claimed in claim 3, characterized in that the control unit (90) has a program-end sensing unit (90h) which is connected to the on/off switch (90b) and transmits, after the termination of a program run for setting one or more functional parameters, a switch-on signal to the on/off switch in order to activate the transmitter and/or receiver stage (5).

5. The mobile phone terminal as claimed in one of the preceding claims, characterized in that at least some of the microswitches or microrelays are integrated with the respectively associated passive structural elements on one and the same substrate, in particular a substrate with a high dielectric constant.

6. The mobile phone terminal as claimed in one of claims 2 to 5, characterized in that at least some of the micromotors are integrated with the respectively associated passive structural elements on one and the same substrate, in particular a substrate with a high dielectric constant.

7. The mobile phone terminal as claimed in one of the preceding claims, characterized in that the control unit (90) has

- a topology memory (90e) for storing the topology of the arrangement which determines the functional parameter or parameters and is composed of passive structural elements and microswitches or microrelays,

- an algorithm memory (90f) for storing a calculation algorithm for predetermined values of each functional parameter on the basis of topology elements, and

- a calculation stage (90d) for determining, on the basis of the stored calculation algorithm, the configuration microswitches or microrelays which are to be actuated in order to implement the predetermined value or the predetermined

values.

8. The mobile phone terminal as claimed in claim 7, characterized in that the topology memory (90e) is designed to store the position and a topology equivalent corresponding to the possible actuator stages of each micromotor, and the calculation stage (90d) is designed to calculate the actuation signal for each micromotor, which signal is to be output in order to implement a predetermined value of the functional parameter.

9. The mobile phone terminal as claimed in one of claims 1 to 7, characterized in that the control unit (C) has

- a configuration memory (M) which is embodied as a lookup table and has the purpose of storing a multiplicity of switched setting configurations of the microswitches or microrelays, in each case in an assignment to a value of a functional parameter or a values vector of a plurality of functional parameters, and

- a pointer stage (P) for addressing the configuration memory as a function of a programmable value or values vector.

10. The mobile phone terminal as claimed in claim 9, characterized in that the configuration memory (M) is designed to store combined switch setting and motor actuation configurations of a structural element arrangement in which not only microswitches or microrelays but also micromotors are provided for adjusting passive structural elements.

11. A method for operating a mobile phone terminal as claimed in one of the preceding claims, characterized in that, in each case before an actuation signal is transmitted to the microswitch configuration or microrelay configuration and optionally to a micromotor,

the transmitter stage and/or receiver stage (5; R/T) is deactivated.

12. The method as claimed in claim 11, characterized in that, in each case after the
5 termination of a program run for setting one or more functional parameters, the transmitter stage and/or receiver stage (5; R/T) is automatically reactivated.

13. A method for operating a mobile phone terminal as claimed in one of claims 1 to 10, characterized in
10 that the microswitches or microrelays which are to be actuated in order to implement the predetermined value or the predetermined values, and optionally micromotors, are determined in real time on the basis of a stored topology of the arrangement which
15 determines the functional parameter or parameters and is composed of passive structural elements and microswitches or microrelays and a stored calculation algorithm for predetermined values of each functional parameter on the basis of topology elements.

14. A method for operating a mobile phone terminal as claimed in one of claims 1 to 10, characterized in
20 that the determination of the microswitches or microrelays which are to be actuated in order to implement a predetermined value or predetermined values of each functional parameter, and optionally
25 micromotors, by addressing a memory location of a configuration memory (M), embodied as a lookup table, in order to store a multiplicity of switched setting configurations of the microswitches or microrelays and
30 optionally micromotors, is performed in each case in an assignment to a value of a functional parameter or a values vector of a plurality of functional parameters by means of a pointer stage (P) as a function of a currently programmed value or values vector.

15. A programmable RF block for mobile phone applications, having

- an active component (104, 105, 106),
- at least one mechanically tunable adapter network (101, 102, 103) which has individually adjustable passive components (107, 108, 109, 110, 111) and is connected to the active component (104, 105, 106), and
- a programmable control unit (117) which sets the mechanically tunable adapter network (101, 102, 103) in such a way that all the properties of the RF block relating to its signal response characteristic are predetermined.

16. The programmable RF block as claimed in claim 15, characterized in that each adjustable passive component (107, 108, 109, 110, 111) is assigned an electric micromotor (112, 113, 114, 115, 116), and the programmable control unit (117) actuates the micromotors (112, 113, 114, 115, 116) in order to set the mechanically tunable adapter network (101, 102, 103).

17. The programmable RF block as claimed in claim 16, characterized in that the micromotors (112, 113, 114, 115, 116) are activated only during the period of adjustment of the mechanically tunable adapter network (101, 102, 103), and outside this period the supply of electricity to the micromotors (112, 113, 114, 115, 116) is switched off.

18. The programmable RF block as claimed in one of the preceding claims, characterized in that a memory (118) is connected to the programmable control unit (117) in which setting values for the mechanically tunable adapter network (101, 102, 103) and/or

predetermined properties of the RF block relating to its signal response characteristic are permanently stored.

19. The programmable RF block as claimed in claim 5 18, characterized in that a table which represents the setting values, necessary to achieve a specific signal response characteristic of the RF block, for the mechanically tunable adapter network (101, 102, 103) is created in the memory (118).

10 20. The programmable RF block as claimed in one of the preceding claims, characterized in that the programmable control unit (117) sets the RF block with respect to its properties relating to the operating frequency, bandwidth, amplification power and/or noise 15 characteristics.

21. The programmable RF block as claimed in one of the preceding claims, characterized in that the programmable control unit (117) itself calculates the setting values, necessary to achieve a specific signal 20 response characteristic of the RF block, for the mechanically tunable adapter network (101, 102, 103).

22. The programmable RF block as claimed in one of the preceding claims, characterized in that the control unit (117) can be programmed over an air interface 25 (124).

23. A mobile phone, characterized

in that it can be programmed over an air interface (124) and has a RF block as claimed in one of claims 15 to 22.

24. A programmable filter circuit for mobile phone applications, having:

- a plurality of passive components (204, 205) whose characteristic values are each mechanically adjustable,
- electric micromotors (208) for mechanically adjusting the passive components (204, 205), and
- 10 - a programmable control unit (217) for actuating the electric micromotors (208) in such a way that the filter circuit (201, 202, 203) has a specific characteristic curve.

25. The filter circuit as claimed in claim 24, characterized in that the control unit (217) is connected to a memory (218) in which setting values of the passive components (204, 205) or actuation values for the corresponding electric micromotors (208) and/or characteristic curves of the filter circuit (201, 202, 203) are stored.

26. The filter circuit as claimed in one of claims 24 or 25, characterized in that the control unit (217) itself calculates the actuation values for the electric micromotors (208) which are to be transmitted in order to achieve a specific characteristic curve of the filter circuit (201, 202, 203).

27. The filter circuit as claimed in one of claims 24 to 26, characterized in that some of the passive components are capacitors (204, 204') which have a mechanically adjustable capacitance and which are constructed with a high dielectric constant using a ceramic technology.

28. The filter circuit as claimed in claim 27, characterized in that the capacitors (204, 204') have rotatable or slidable metal plates (211).

29. The filter circuit as claimed in one of claims 5 24 to 28, characterized in that some of the passive components are resonators (205), it being possible to change the position of a short-circuit conductor (215) with respect to a grounding point (212) by means of the corresponding electric micromotor (208) in order to 10 mechanically adjust the characteristic values of the resonators (205).

30. The filter circuit as claimed in one of claims 24 to 29, characterized in that the electric micromotors (208) are electrically supplied with power 15 only during the period in which a corresponding passive component (204, 205) is being mechanically adjusted.

31. A programmable duplexer for mobile phone applications, having a plurality of programmable filter circuits as claimed in one of claims 24 to 30.

1/10

FIG 1

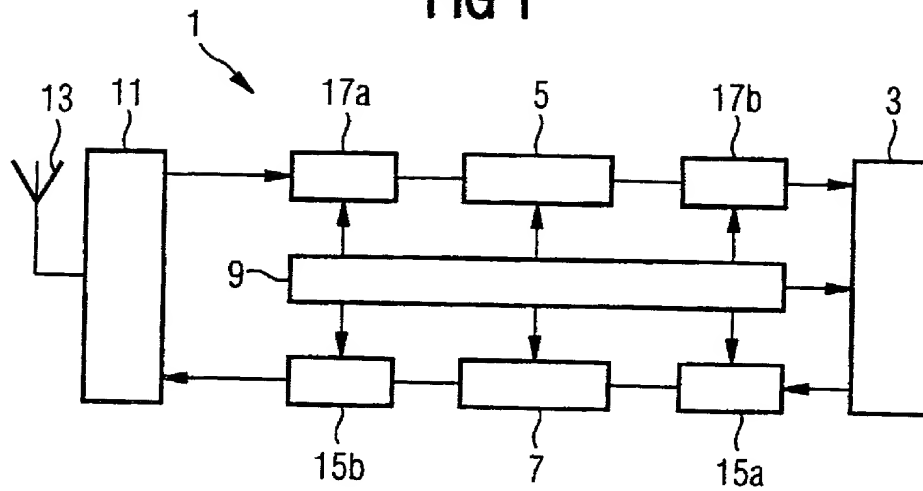


FIG 2A

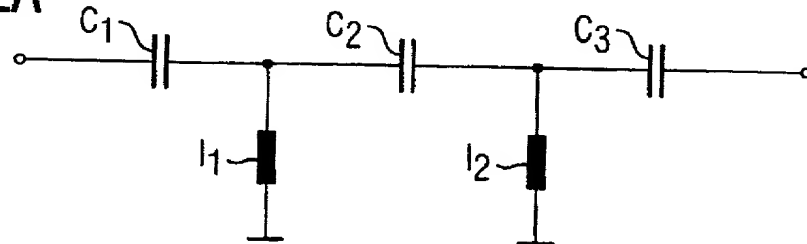
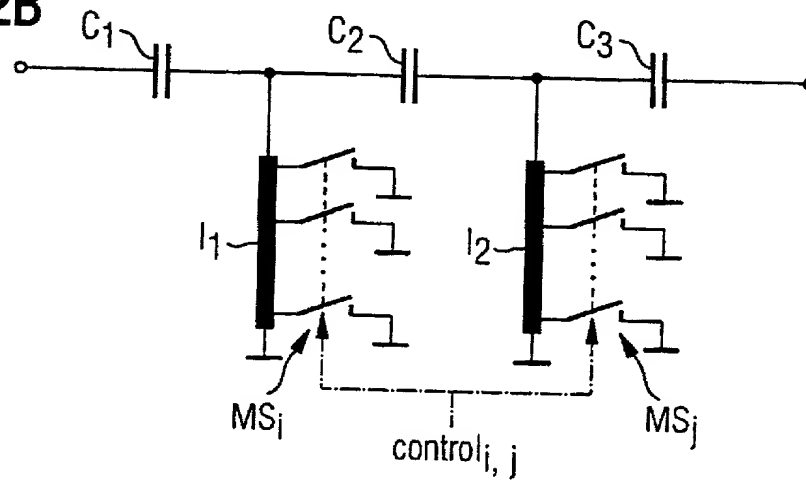


FIG 2B



2/10

FIG 2C

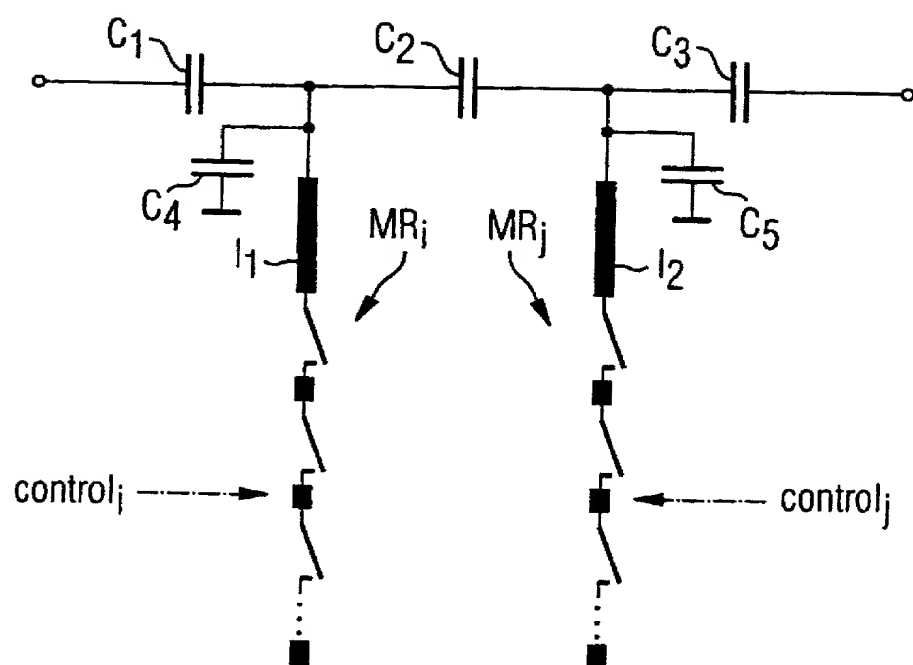
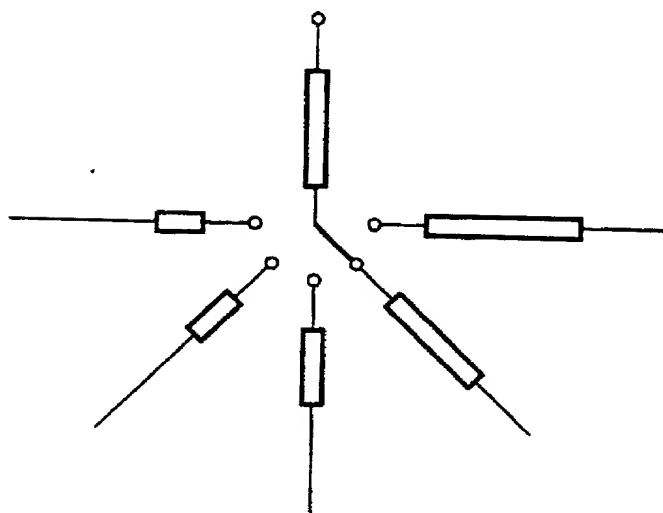


FIG 2D



3/10

FIG 2E

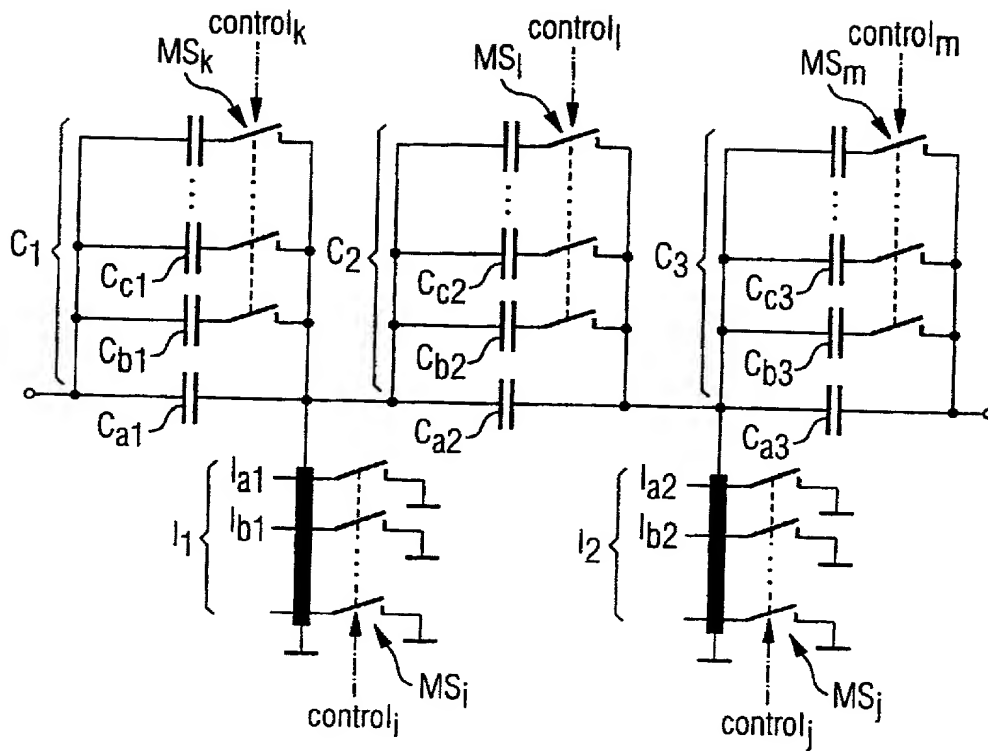


FIG 2F

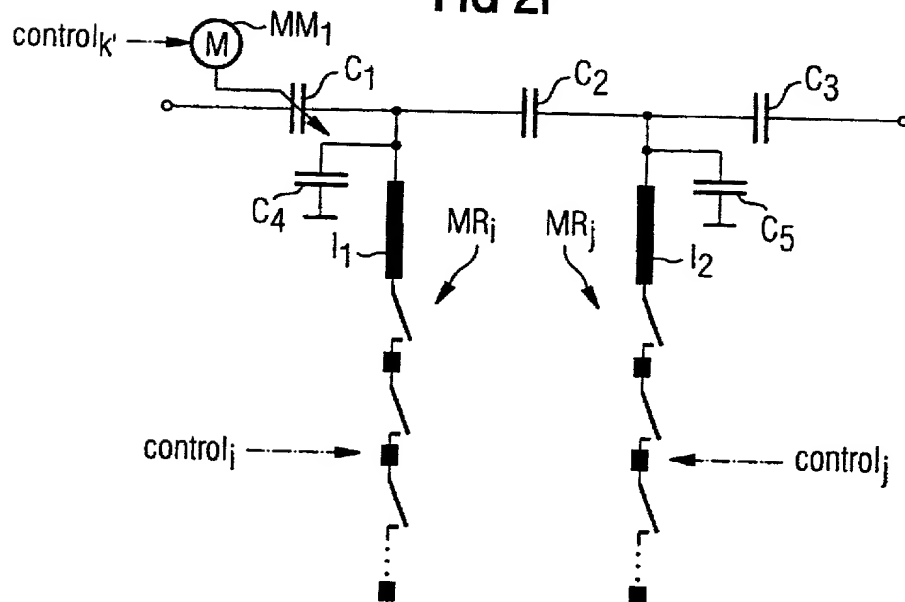


FIG 2G

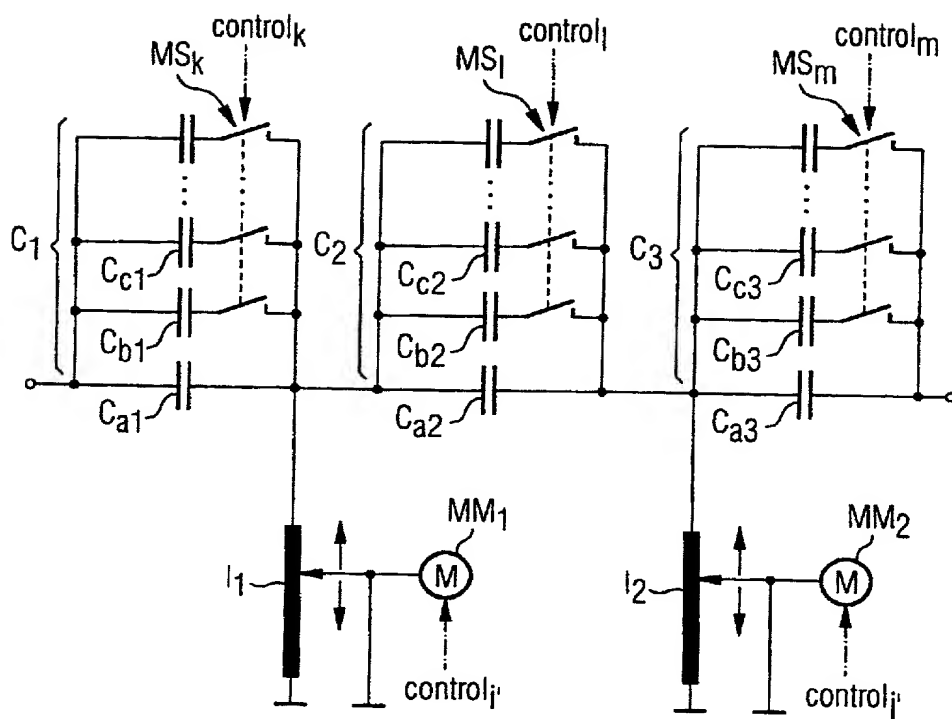


FIG 3

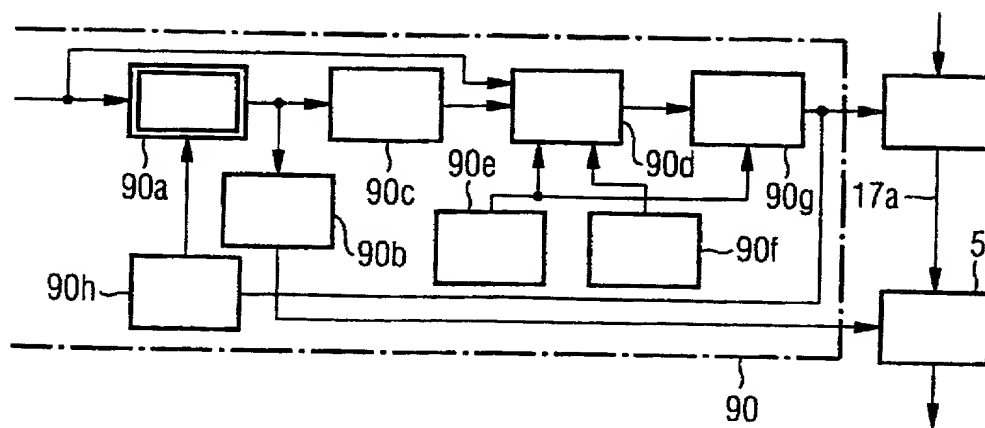
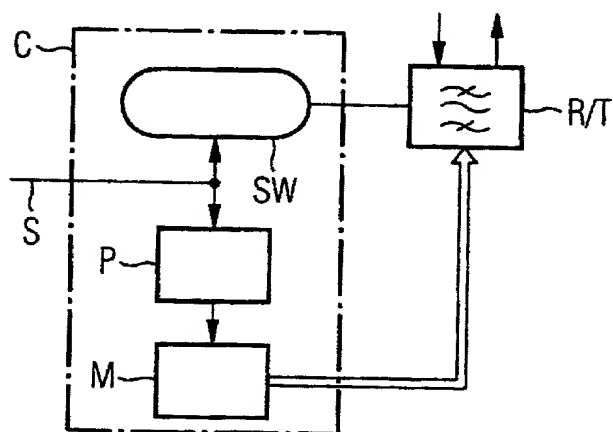


FIG 4



6/10

FIG 5A

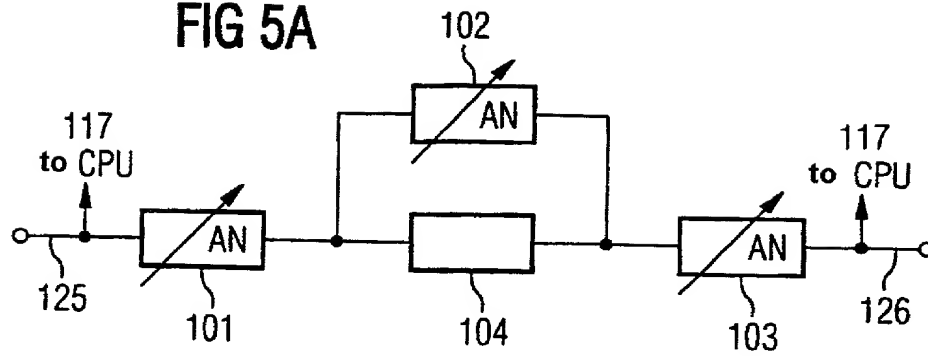


FIG 5B

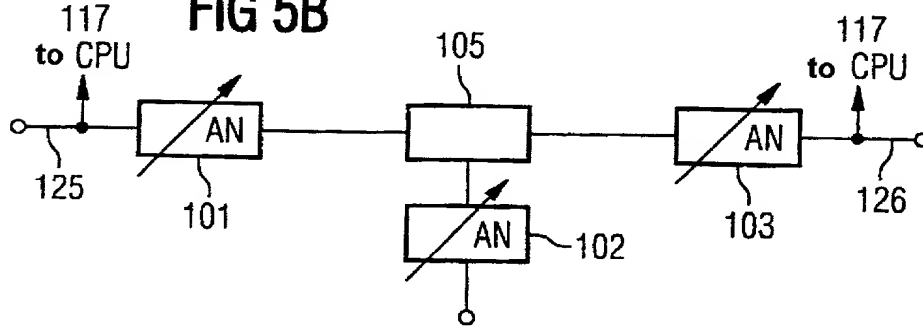


FIG 5C

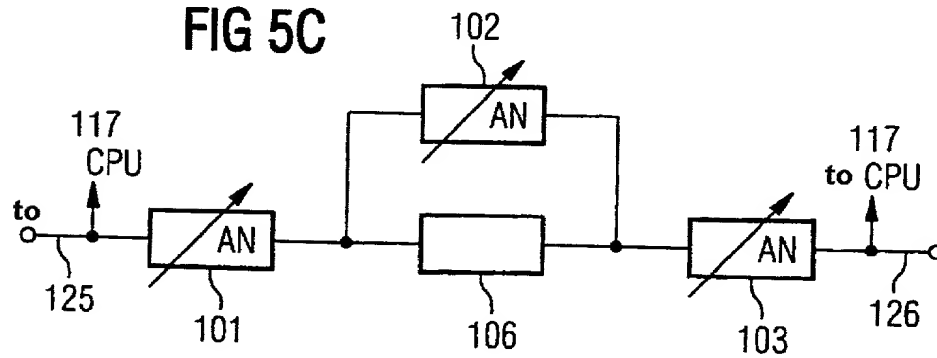
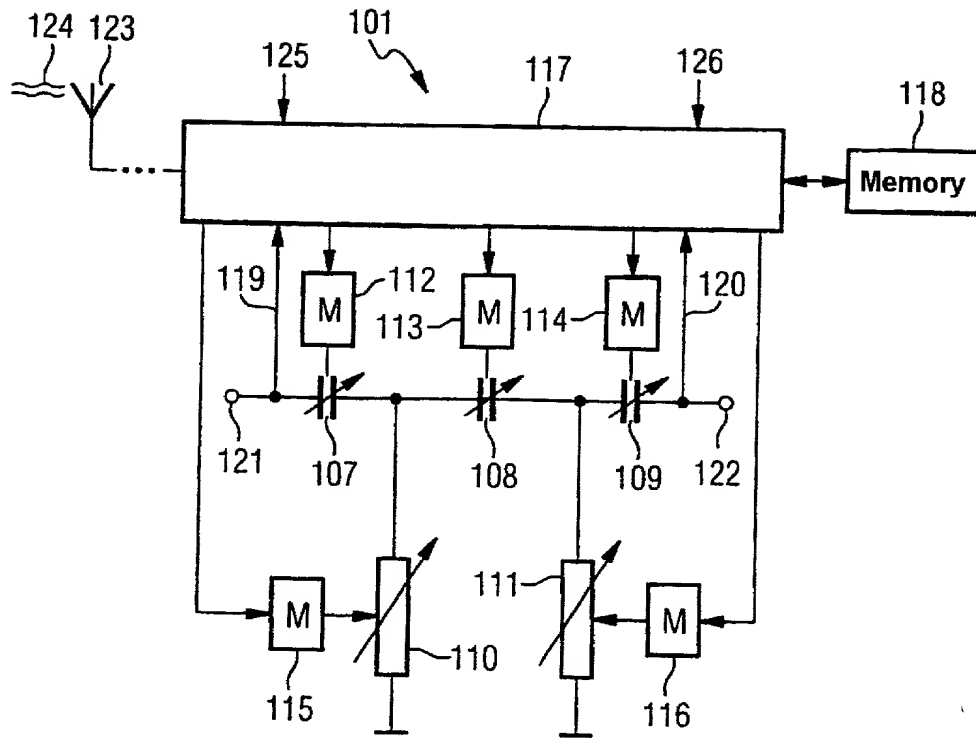


FIG 6



8/10

FIG 7A

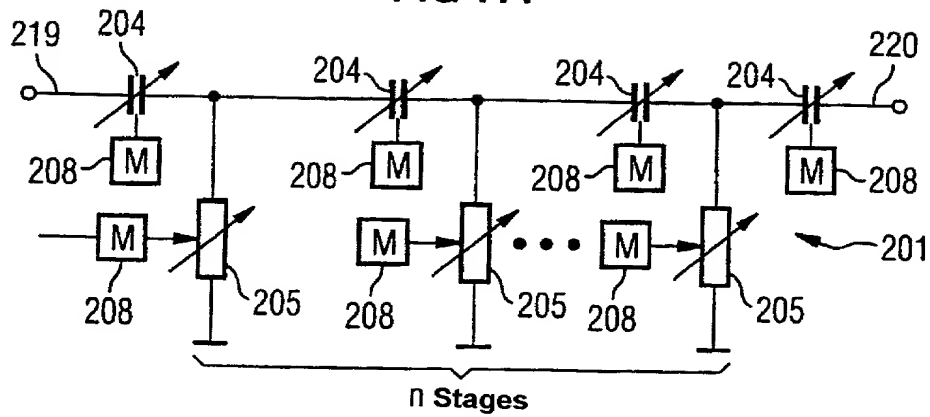
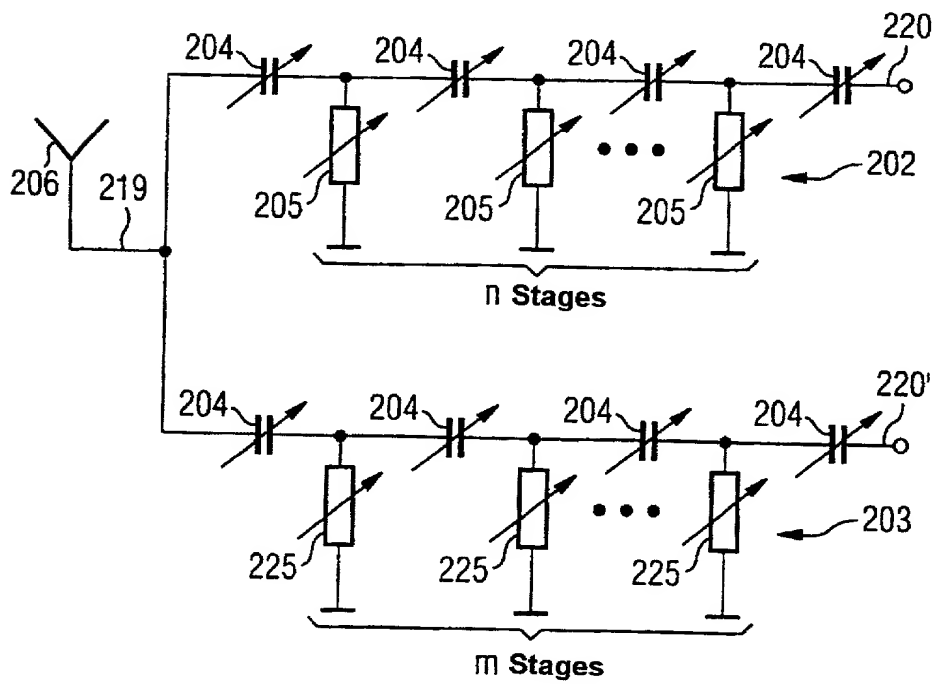


FIG 7B



9/10

FIG 8

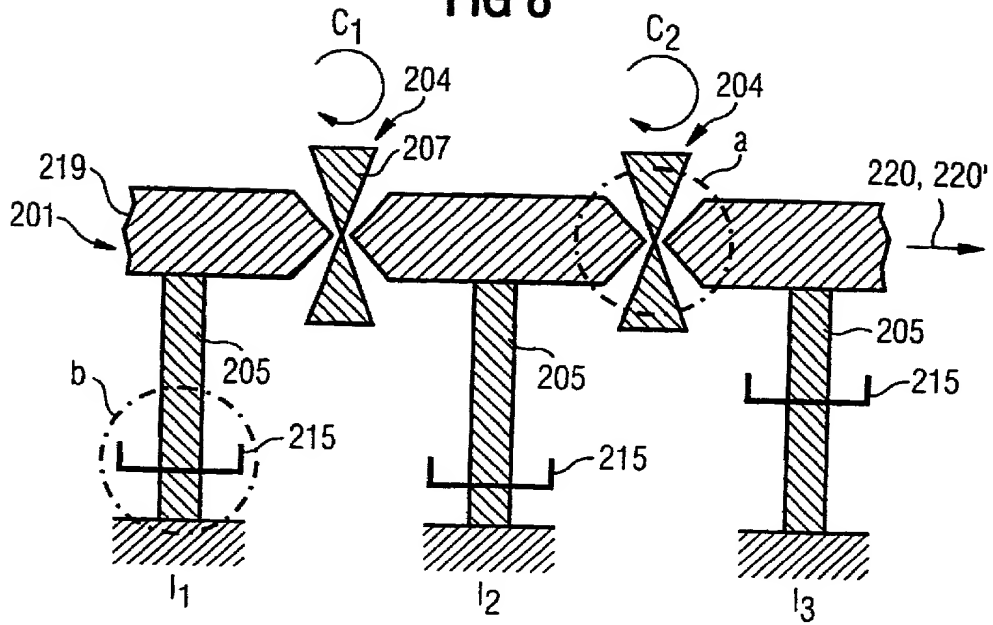
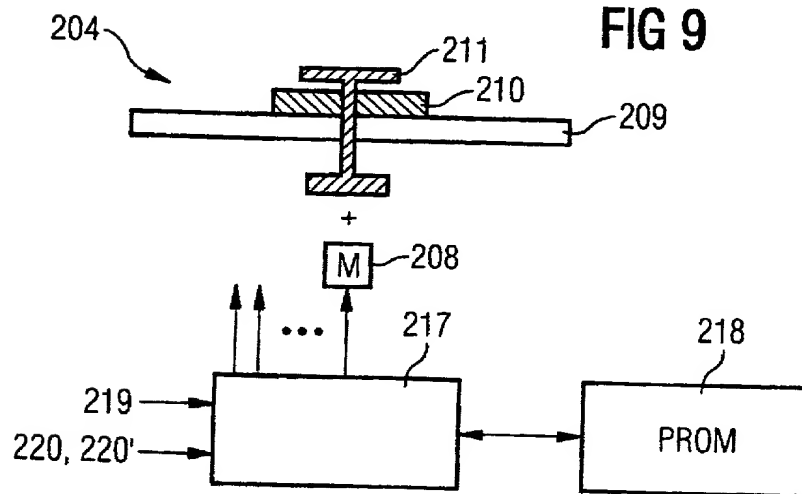


FIG 9



10/10

FIG 10

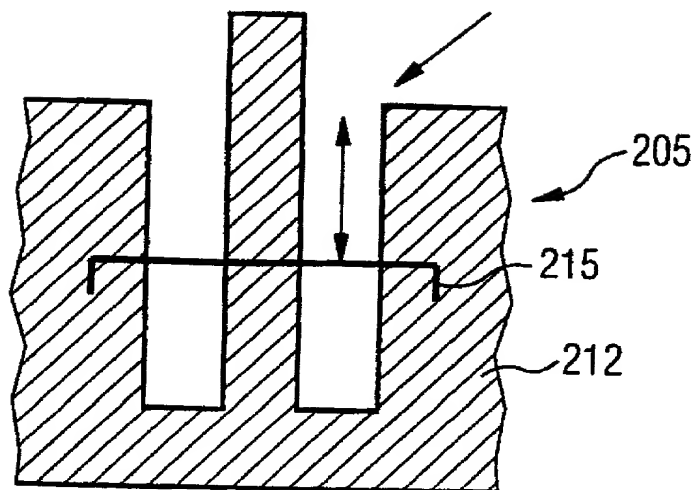
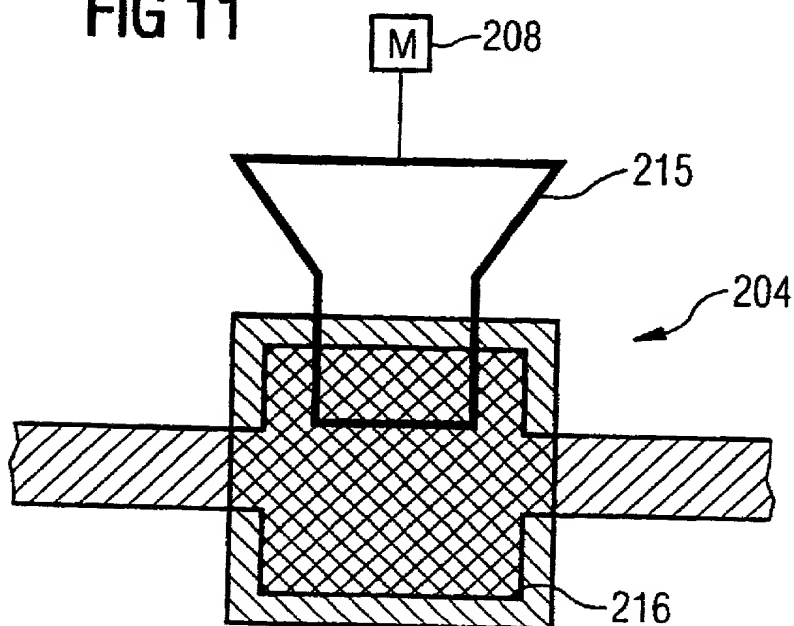


FIG 11



Declaration and Power of Attorney For Patent Application

Erklärung Für Patentanmeldungen Mit Vollmacht

German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

dass mein Wohnsitz, meine Postanschrift, und meine Staatsangehörigkeit den im Nachstehenden nach meinem Namen aufgeführten Angaben entsprechen,

dass ich, nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent beantragt wird für die Erfindung mit dem Titel:

Programmierbares Mobilfunk-Endgerät

deren Beschreibung

(zutreffendes ankreuzen)

☐ hier beigefügt ist.

☒ am 24.09.1999 als

PCT internationale Anmeldung

PCT Anmeldungsnummer PCT/DE99/03079

eingereicht wurde und am _____

abgeändert wurde (falls tatsächlich abgeändert).

Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) von Wichtigkeit sind, an.

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Programmable mobile radiotelephone terminal

the specification of which

(check one)

☐ is attached hereto.

☒ was filed on 24.09.1999 as

PCT international application

PCT Application No. PCT/DE99/03079

and was amended on _____

(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

German Language Declaration

Prior foreign applications
Priorität beansprucht

Priority Claimed

19844142.8
(Number)
(Nummer)

DE
(Country)
(Land)

25.09.1998
(Day Month Year Filed)
(Tag Monat Jahr eingereicht)

☒ ☐
Yes No
Ja Nein

19844143.6
(Number)
(Nummer)

DE
(Country)
(Land)

25.09.1998
(Day Month Year Filed)
(Tag Monat Jahr eingereicht)

☒ ☐
Yes No
Ja Nein

19919368.1
(Number)
(Nummer)

DE
(Country)
(Land)

28.04.1999
(Day Month Year Filed)
(Tag Monat Jahr eingereicht)

☒ ☐
Yes No
Ja Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §122, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

PCT/DE99/03079
(Application Serial No.)
(Anmeldeseriennummer)

24.09.1999
(Filing Date D, M, Y)
(Anmeldedatum T, M, J)

(Status)
(patentiert, anhängig,
aufgegeben)

(Status)
(patented, pending,
abandoned)

(Application Serial No.)
(Anmeldeseriennummer)

(Filing Date D, M, Y)
(Anmeldedatum T, M, J)

(Status)
(patentiert, anhängig,
aufgeben)

(Status)
(patented, pending,
abandoned)

Ich erkläre hiermit, dass alle von mir in der vorliegenden Erklärung gemachten Angaben nach meinem besten Wissen und Gewissen der vollen Wahrheit entsprechen, und dass ich diese eidesstattliche Erklärung in Kenntnis dessen abgebe, dass wissentlich und vorsätzlich falsche Angaben gemäss Paragraph 1001, Absatz 18 der Zivilprozessordnung der Vereinigten Staaten von Amerika mit Geldstrafe belegt und/oder Gefängnis bestraft werden koennen, und dass derartig wissentlich und vorsätzlich falsche Angaben die Gültigkeit der vorliegenden Patentanmeldung oder eines darauf erteilten Patentes gefährden können.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

German Language Declaration

VERTRETUNGSVOLLMACHT: Als benannter Erfinder beauftrage ich hiermit den nachstehend benannten Patentanwalt (oder die nachstehend benannten Patentanwälte) und/oder Patent-Agenten mit der Verfolgung der vorliegenden Patentanmeldung sowie mit der Abwicklung aller damit verbundenen Geschäfte vor dem Patent- und Warenzeichenamt: (Name und Registrationsnummer anführen)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

Customer No. 26161

And I hereby appoint

Telefongespräche bitte richten an:
(Name und Telefonnummer)

Direct Telephone Calls to: (name and telephone number)

Ext. _____

Postanschrift:

Send Correspondence to:

Fish & Richardson P.C.
225 Franklin Street 02110-2804 Boston, MA
Telephone: +1 617-542 5070 and Facsimile +1 617-542 8906
or
Customer No. 26161

Voller Name des einzigen oder ursprünglichen Erfinders: BERND BIENEK		Full name of sole or first inventor: BERND BIENEK	
Unterschrift des Erfinders <i>Bernd Bienek</i>	Datum <i>15.3.01</i>	Inventor's signature	Date
Wohnsitz BOCHOLT, DEUTSCHLAND		Residence BOCHOLT, GERMANY	
Staatsangehörigkeit DE		Citizenship DE	
Postanschrift ACKERSTR. 3		Post Office Address ACKERSTR. 3	
46395 BOCHOLT		46395 BOCHOLT	
Voller Name des zweiten Miterfinders (falls zutreffend): DIETMAR GAPSKI		Full name of second joint inventor, if any: DIETMAR GAPSKI	
Unterschrift des Erfinders <i>Dietmar Gapski</i>	Datum <i>15.3.2001</i>	Second Inventor's signature	Date
Wohnsitz BOCHOLT, DEUTSCHLAND		Residence BOCHOLT, GERMANY	
Staatsangehörigkeit DE		Citizenship DE	
Postanschrift IM OSTERESCH 25		Post Office Address IM OSTERESCH 25	
46397 BOCHOLT		46397 BOCHOLT	

(Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).

(Supply similar information and signature for third and subsequent joint inventors).

Voller Name des dritten Miterfinders: KLAUS-DIETER PILLEKAMP		Full name of third joint inventor: KLAUS-DIETER PILLEKAMP	
Unterschrift des Erfinders <i>Klaus Dieter Pillekamp</i>	Datum 26.03.01	Inventor's signature	Date
Wohnsitz ERKRATH, DEUTSCHLAND		Residence ERKRATH, GERMANY	
Staatsangehörigkeit DE		Citizenship DE	
Postanschrift GALILEISTR. 4		Post Office Address GALILEISTR. 4	
40699 ERKRATH		40699 ERKRATH	
Voller Name des vierten Miterfinders: Dr. XIHE TUO		Full name of fourth joint inventor: Dr. XIHE TUO	
Unterschrift des Erfinders <i>Xihe Tuo</i>	Datum 5-16-01	Inventor's signature	Date
Wohnsitz DUISBURG, DEUTSCHLAND		Residence DUISBURG, GERMANY	
Staatsangehörigkeit DE		Citizenship DE	
Postanschrift GRABENSTR. 133		Post Office Address GRABENSTR. 133	
47057 DUISBURG		47057 DUISBURG	
Voller Name des fünften Miterfinders:		Full name of fifth joint inventor:	
Unterschrift des Erfinders	Datum	Inventor's signature	Date
Wohnsitz		Residence	
Staatsangehörigkeit		Citizenship	
Postanschrift		Post Office Address	
Voller Name des sechsten Miterfinders:		Full name of sixth joint inventor:	
Unterschrift des Erfinders	Datum	Inventor's signature	Date
Wohnsitz		Residence	
Staatsangehörigkeit		Citizenship	
Postanschrift		Post Office Address	

(Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).

(Supply similar information and signature for third and subsequent joint inventors).